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**Article:**
Fotios, S. orcid.org/0000-0002-2410-7641 (2017) Measure for Measure. Semi-cylindrical illuminance: a semi-conceived measure? Lighting Journal , 82 (2). pp. 34-35. ISSN 0950-4559

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MEASURE FOR MEASURE

# Semi-cylindrical illuminance: a semi-conceived measure?

Lighting Journal, February 2017; 82(2); 34-35

Semi-cylindrical illuminance has been promoted as a better measure for lighting design than vertical illuminance. Professor Steve Fotios is unconvinced

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Illuminance is a measure of the amount of light reaching a surface, more precisely defined as the total luminous flux incident on a surface, per unit area. Road lighting standards for subsidiary roads tend to focus on horizontal surface illuminance, light incident upon the road surface. It may also be desirable to light vertical surfaces, such as faces and building facades, in which case there may be a need to specify also vertical surfaces target illuminances. Some texts suggest that semi-cylindrical illuminance is a better measure than vertical illuminance, arguing this is because the face is not flat and light on sides of the face also contribute to its visibility.

Semi-cylindrical illuminance is the averaged illuminance on the curved surface of an upright semi-cylinder. It has been promoted as a better measure than vertical illuminance for characterising the ability to evaluate faces apparently because it sounds like that should be the case, and so is assumed to be despite the lack of factual evidence. For example, one source states that: ‘semi cylindrical illuminance has a significant *“side lighting” effect which* the vertical illuminance has none. Semi cylindrical illuminance brings out the roundness, the three dimensionality of the human form’ [1]. See also guidance from IESNA [2], which states: ‘For a number of reasons pure vertical illuminance from whatever direction is not the optimum parameter. The comparatively recent introduction of the concept of semi-cylindrical illuminance has therefore been included in this guide’ but without revealing what those reasons were nor how they are overcome by using semi-cylindrical illuminance.

Selecting the lighting class for a subsidiary road (BS 5489-1:2013, Tables A.5 and A.6) leads to a specific P-class, the conditions for which are given in Table 3 of EN 13201-2:2015, shown here as Table 1. This specifies a minimum semi-cylindrical illuminance in each class as an ‘additional requirement if facial recognition is necessary’. In areas where there are particular concerns about crime, a need for facial recognition, or where CCTV is present, BS5489-1:2013 directly recommends using semi-cylindrical illuminance, referring to the ES-

series of lighting classes (Table 5 in BS EN 13201-2:2003). These were later replaced by the SC lighting classes EN 13201-2:2015 but are otherwise identical, a series of nine classes of semi-cylindrical illuminance ranging from 0.5 to 10 lux.

| Lighting Class | Average horizontal illuminance (lux) | Minimum horizontal illuminance (lux) | Additional requirement if facial recognition is necessary. | |
|---|---|---|---|---|
| | | | Minimum maintained vertical illuminance (lux) | Minimum semi-cylindrical illuminance (lux) |
| P1 | 15 | 3.0 | 5.0 | 5.0 |
| P2 | 10 | 2.0 | 3.0 | 2.0 |
| P3 | 7.5 | 1.5 | 2.5 | 1.5 |
| P4 | 5.0 | 1.0 | 1.5 | 1.0 |
| P5 | 3.0 | 0.6 | 1.0 | 0.6 |
| P6 | 2.0 | 0.4 | 0.6 | 0.2 |

**Table 1**. P lighting classes for pedestrians and pedal cyclists [EN 13201-2:2015].

## ORIGIN WITHIN ROAD LIGHTING

The concept of semi-cylindrical illuminance within road lighting design appears to have originated in articles by Caminada and van Bommel [3] and Rombauts et al [4]. Subsequent works perpetuating semi-cylindrical illuminance tend to refer to these two studies without questioning the basis of their proposals.

Rombauts et al investigated facial recognition and alleged a 'very good correlation between the facial recognition distance and the value of $E_{SC}$.' However, they did not consider any other metrics of illuminance (horizontal, vertical, etc) and so are not able to state whether semi-cylindrical illuminance was better or worse than these. That is not sufficient reason to favour semi-cylindrical illuminance ahead of any other measure: they would very likely have found equally good correlation if using vertical illuminance but did not raise that question.

The investigation by Caminada and van Bommel did investigate different metrics but their analysis of the test results was not sufficiently robust to support the concluded preference for semi-cylindrical illuminance. Three types of illuminance were

measured during their facial recognition test: data were presented, however, for only two of these, vertical and semi-cylindrical illuminances, but not the third, hemispherical illuminance. They claimed that there was ‘no reliable correlation’ between face recognition distance and vertical illuminance, but ‘good correlation’ between semi-cylindrical illuminance and face recognition distance. This conclusion is not convincing because the degree to which correlation exists should be determined by statistical analysis and that was not reported in this work.

There is, however, evidence which rejects semi-cylindrical illuminance. Boyce et al [5] found a high degree of correlation between the cylindrical and horizontal illuminances derived from cubic illuminances measured at 25 outdoor locations, concluding that either ‘*could be equally well related to subjects’ opinions*’ and chose therefore to use horizontal illuminance.

Alferdinck et al [6] concluded following a face recognition experiment that semi-cylindrical illuminance did not give a better prediction of the results than vertical illuminance, but this report did not present a statistical analysis to support that conclusion.

Simons et al [7] analysed the ‘overall impression’ of road lighting in 12 locations and commented that “The results taken in total indicate that hemispherical and semi-cylindrical illuminance give slightly worse correlation with the appraisals than does horizontal illuminance. On the basis of the appraisals, therefore, there appears to be no advantage in adopting hemispherical or semi-cylindrical in preference to horizontal illuminance.” Again, however, there are no reported results to validate the claim.

**SUMMARY**

While road lighting standards tend to focus on horizontal surface illuminance, it may also be desirable to see vertical surfaces such as faces and building facades. These are likely to be illuminated anyway by road lighting, either by direct illumination from lamps or indirect illumination from reflection from other surfaces. It was assumed in BS5489-1:2003 that ‘The provision of lighting designed to meet the requirements of the appropriate horizontal illuminance class normally provides adequate vertical

illuminance at the height of the human face, ensuring a high possibility of recognition'. The move toward lanterns of greater cut-off and more-precise optics may have led to a need now to specify target illuminances for vertical surfaces rather than simply assuming this is the case.

Some design guides recommend values of semi-cylindrical illuminance. There is no credible evidence (yet found) showing an advantage to using semi-cylindrical rather than vertical illuminance. Semi-cylindrical illuminance is a widely-repeated possibility that has yet to be substantiated. Because semi-cylindrical illuminance is still a single number quantifying a magnitude of light, this alone does not provide more information about the distribution of light in a space than does vertical illuminance, such as light reaching the sides of a face. Promoting semi-cylindrical illuminance would require designers and installers to invest in new meters for which there would be reluctance unless a clear advantage can be shown.

The conclusion therefore is that designers should consider vertical illuminance but not semi-cylindrical illuminance. This does not mean that semi-cylindrical illuminance is an irrelevant metric, but rather that there does not yet appear to be any clear and robust evidence for its need, nor for the values that should be targeted.

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